sPHENIX EMCal

Electronics/SiPM R&D at BNL

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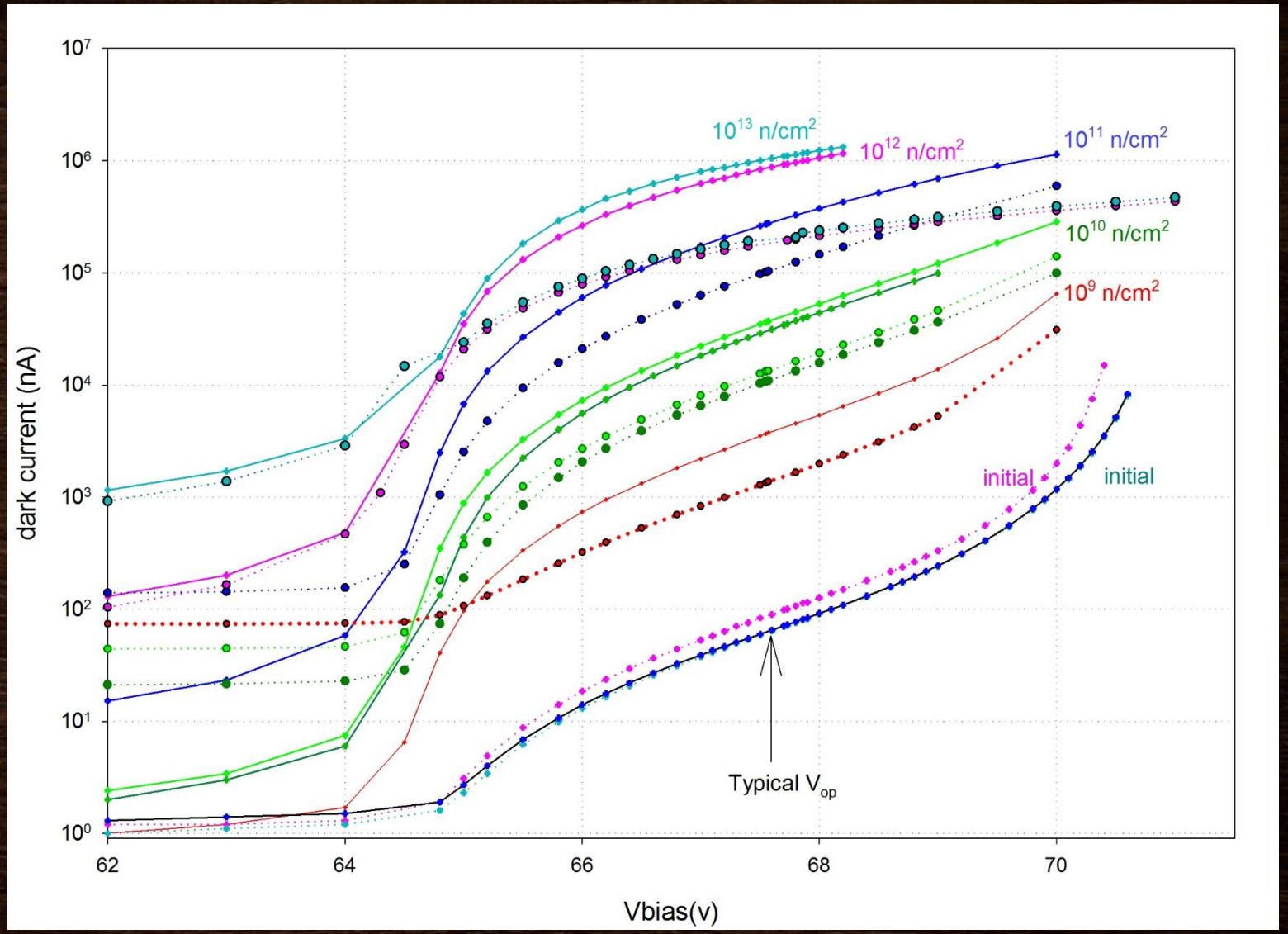
UIUC SPHENIX EMCAL WORKFEST 8/2015

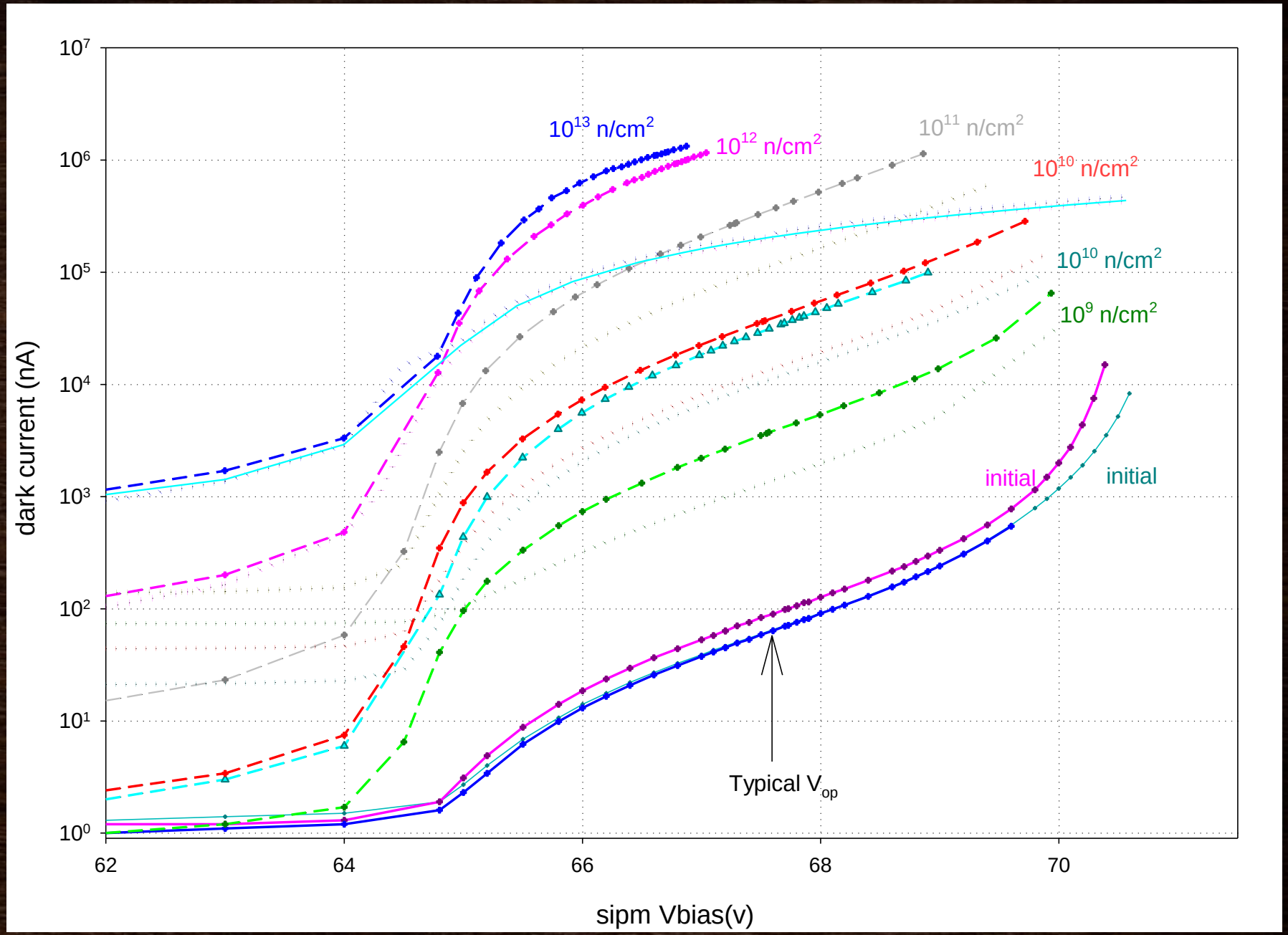
radiation damage:
increased dark (supply) current with exposure

Note (added 8/17): As discussed at the mtg, Vbias here is the total supply voltage. It would be better to plot this vs delta V across the sipm, which would result in slightly higher post-irradiation currents. Correceted graph is in the next slide.



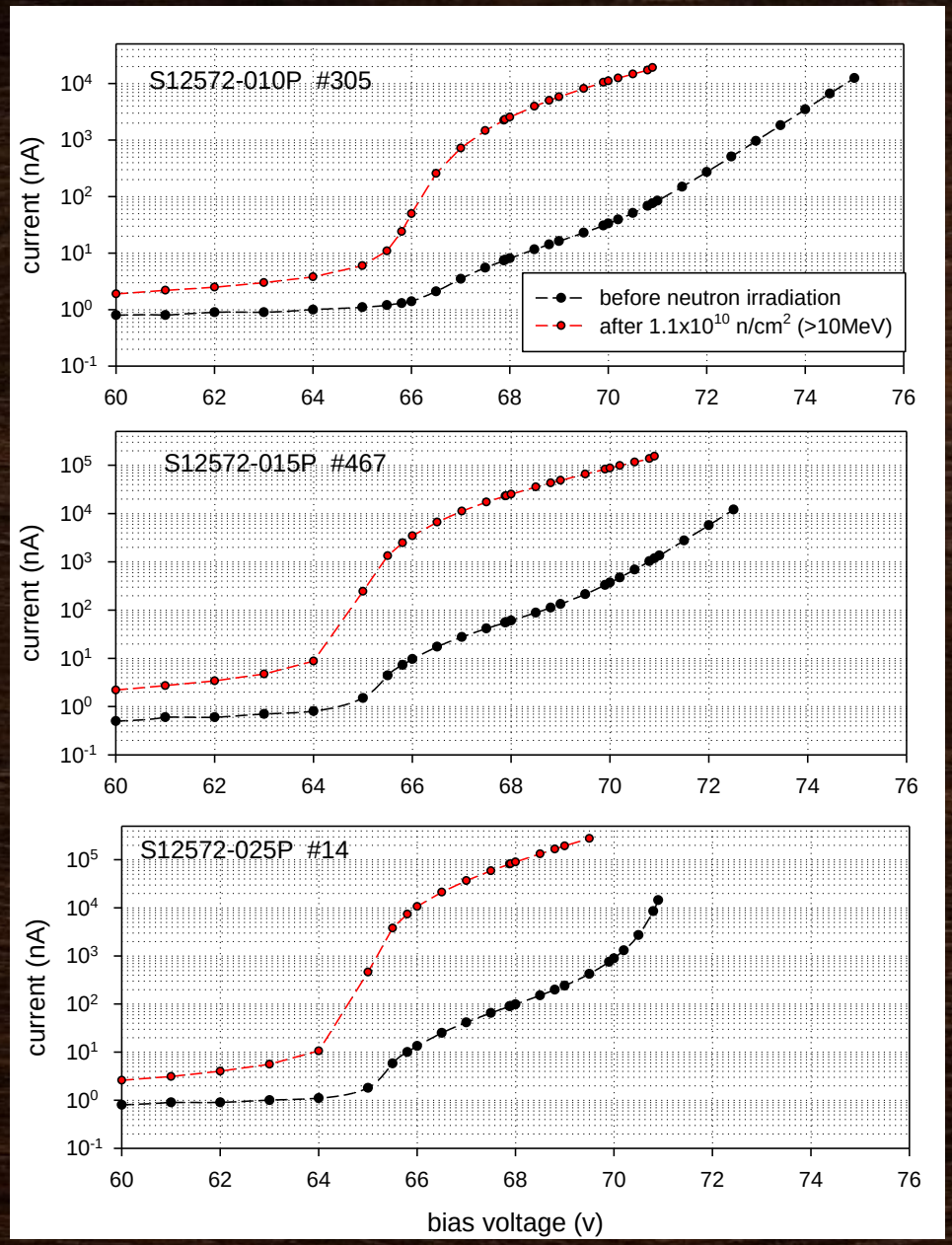
radiation damage:
increased dark current with exposure.
Dark current as a function of bias voltage across sipm – corrected for voltage drops across other resistive circuit elements.

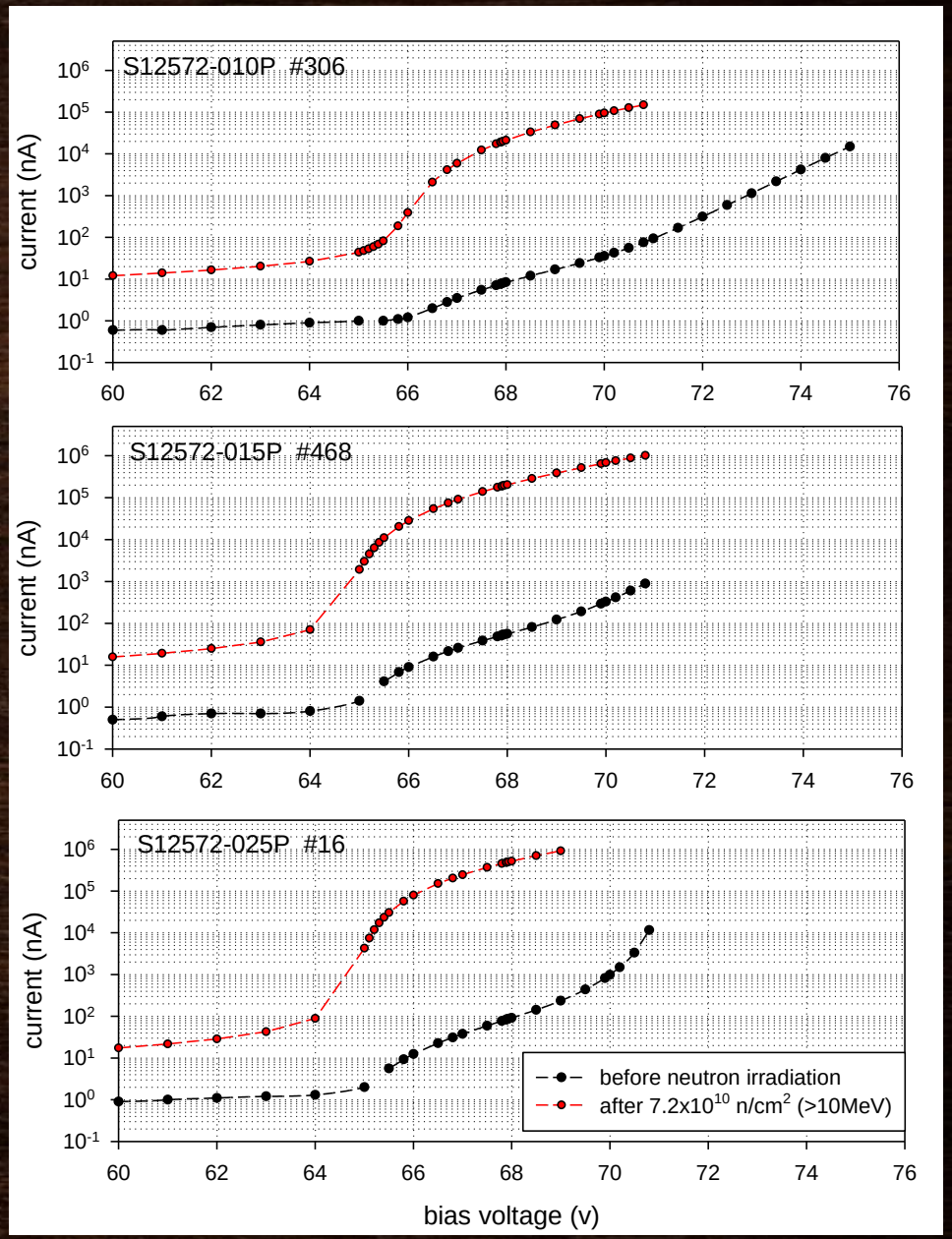
The dotted curves show recovery (decrease) in current with time, after irradiation.



neutron irradiation at LANSCE

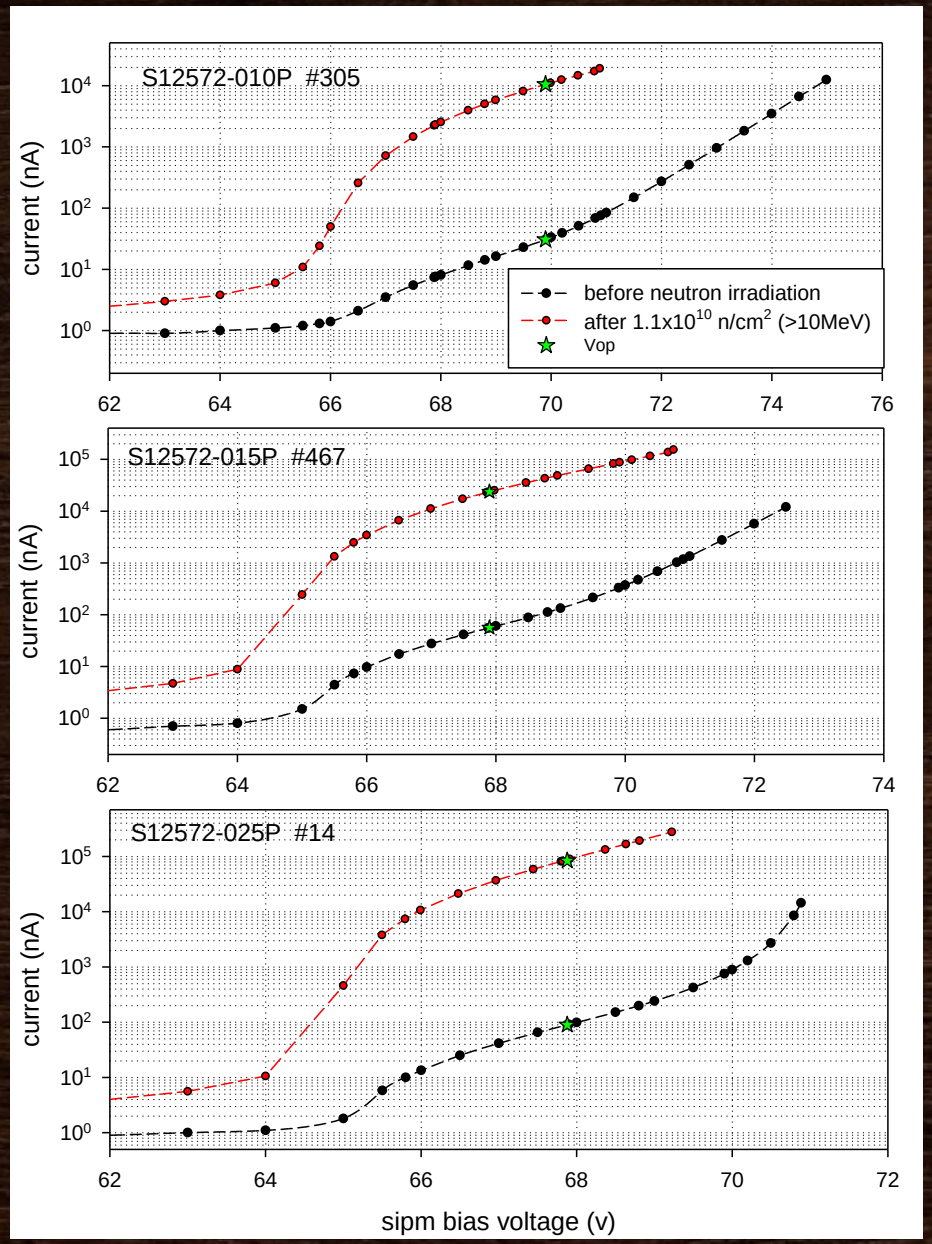
Note (added 8/17): As discussed at the mtg, Vbias here is the total supply voltage. It would be better to plot this vs delta V across the sipm, which would result in slightly higher post-irradiation currents. See next slide for corrected plots.

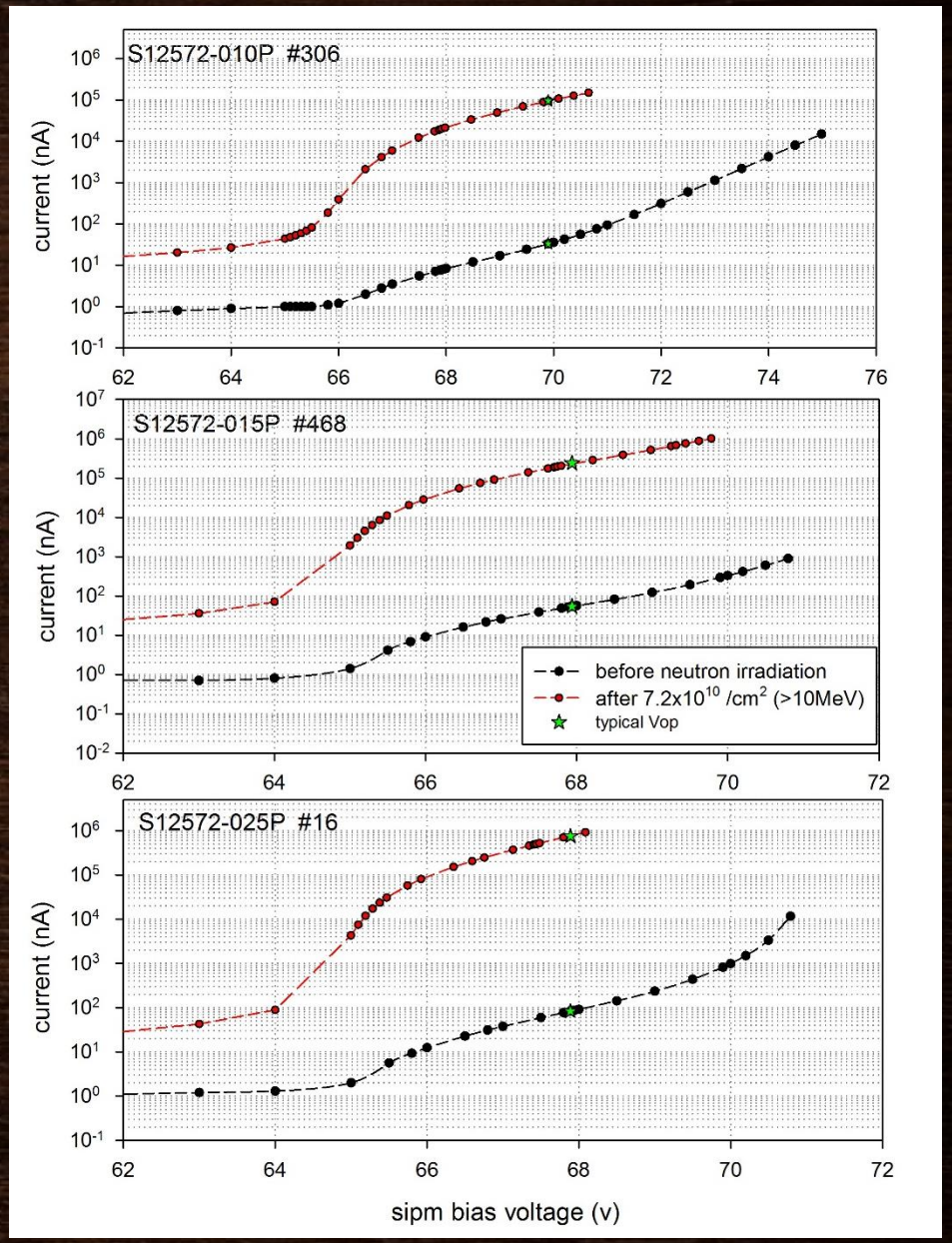




Dark current vs bias voltage, measured before and after irradiation.

neutron irradiation
at LANSCE

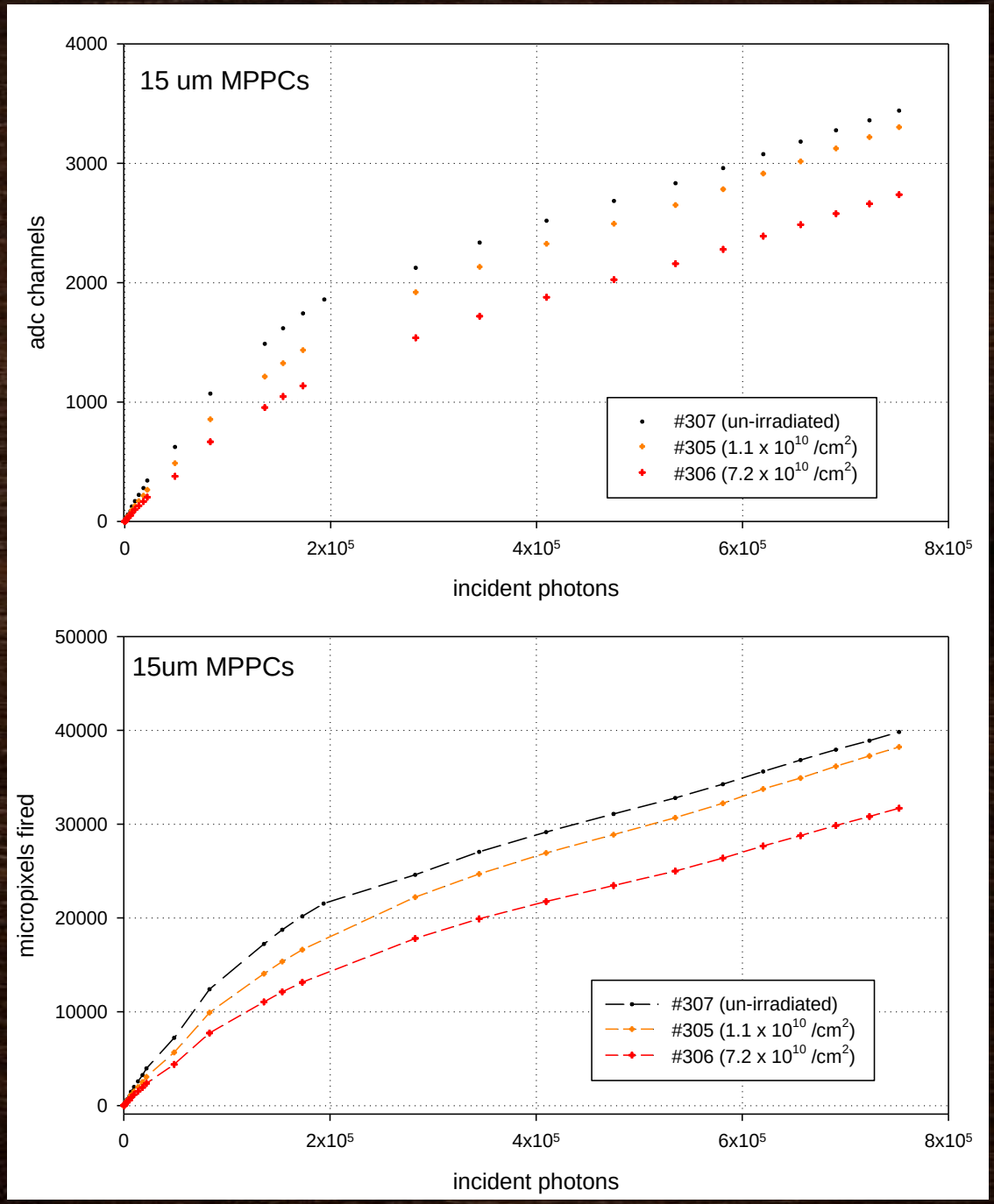




Dark current vs bias voltage, measured before and after irradiation.

neutron irradiation
at LANSCE

Note (added 8/17): As discussed at the mtg, these measurements were taken at constant V_{supply}, without compensating for decreased gain from the increased current and change in the actual voltage drop across the sipm.

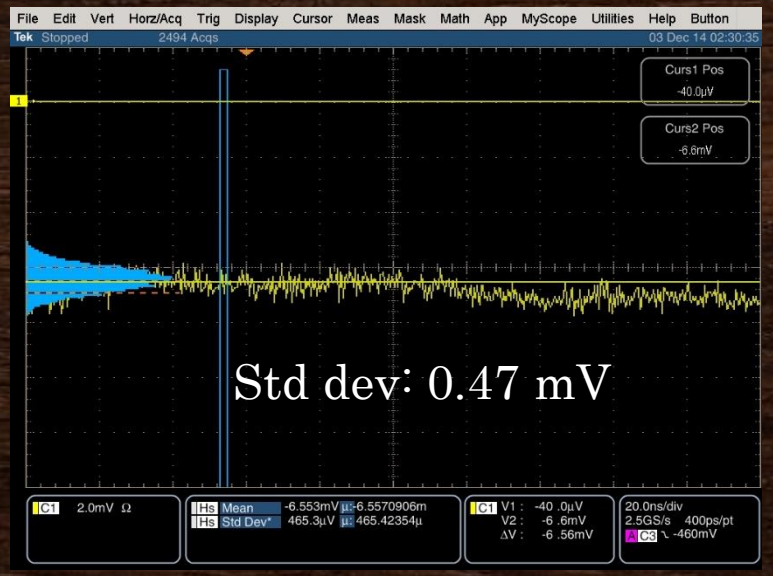


MPPCs - sPHENIX preamp /LED pulser peak and pedestal measured after irradiation (7.2×10^{10} / cm^2).

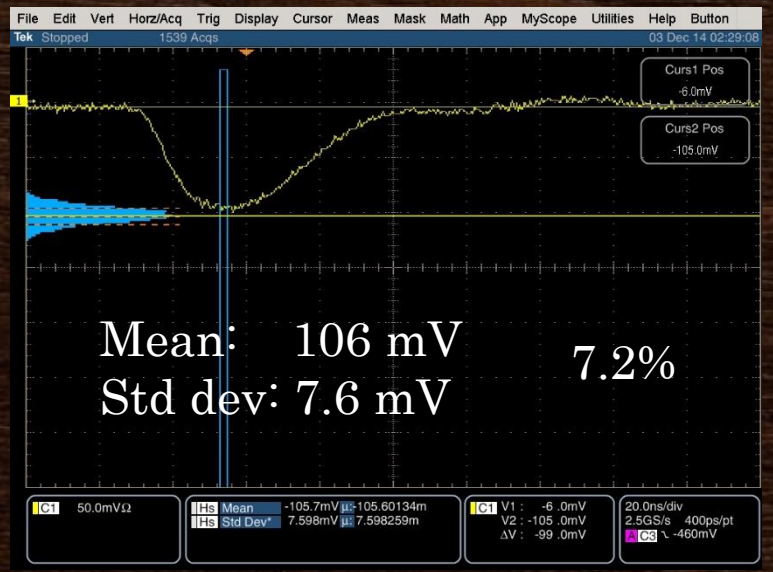
Before irradiation

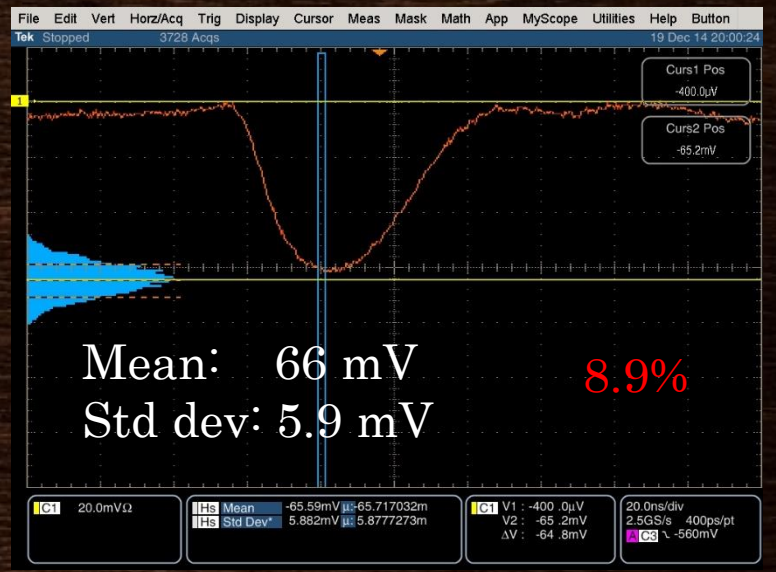
After irradiation

pedestal



Peak





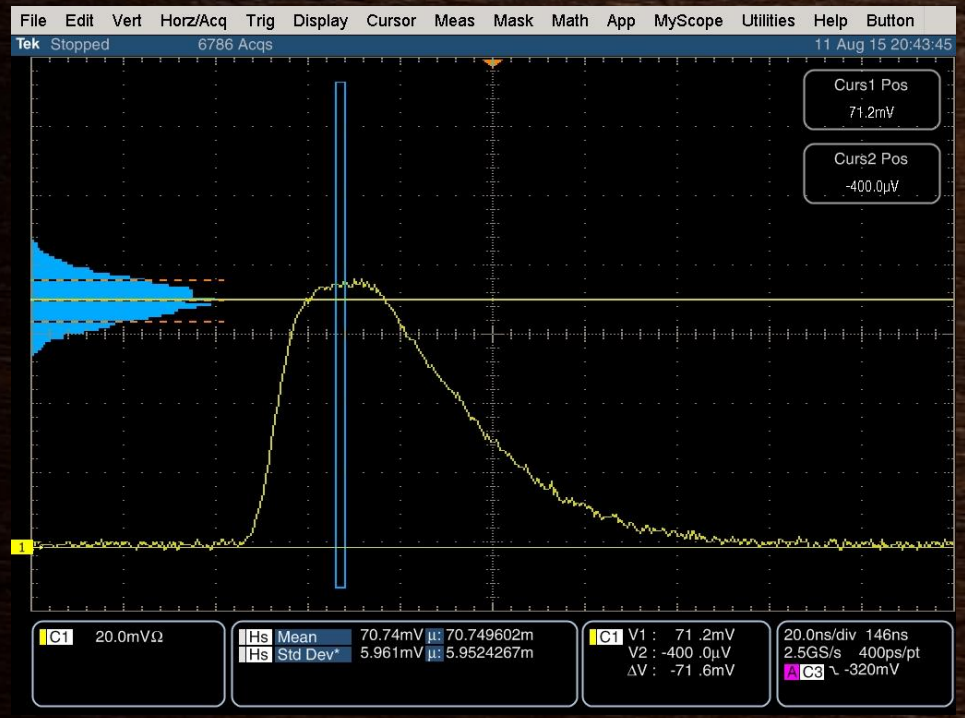
neutron irradiation
at LANSCE

Combined Test of -015P sipm and sPhenix preamp

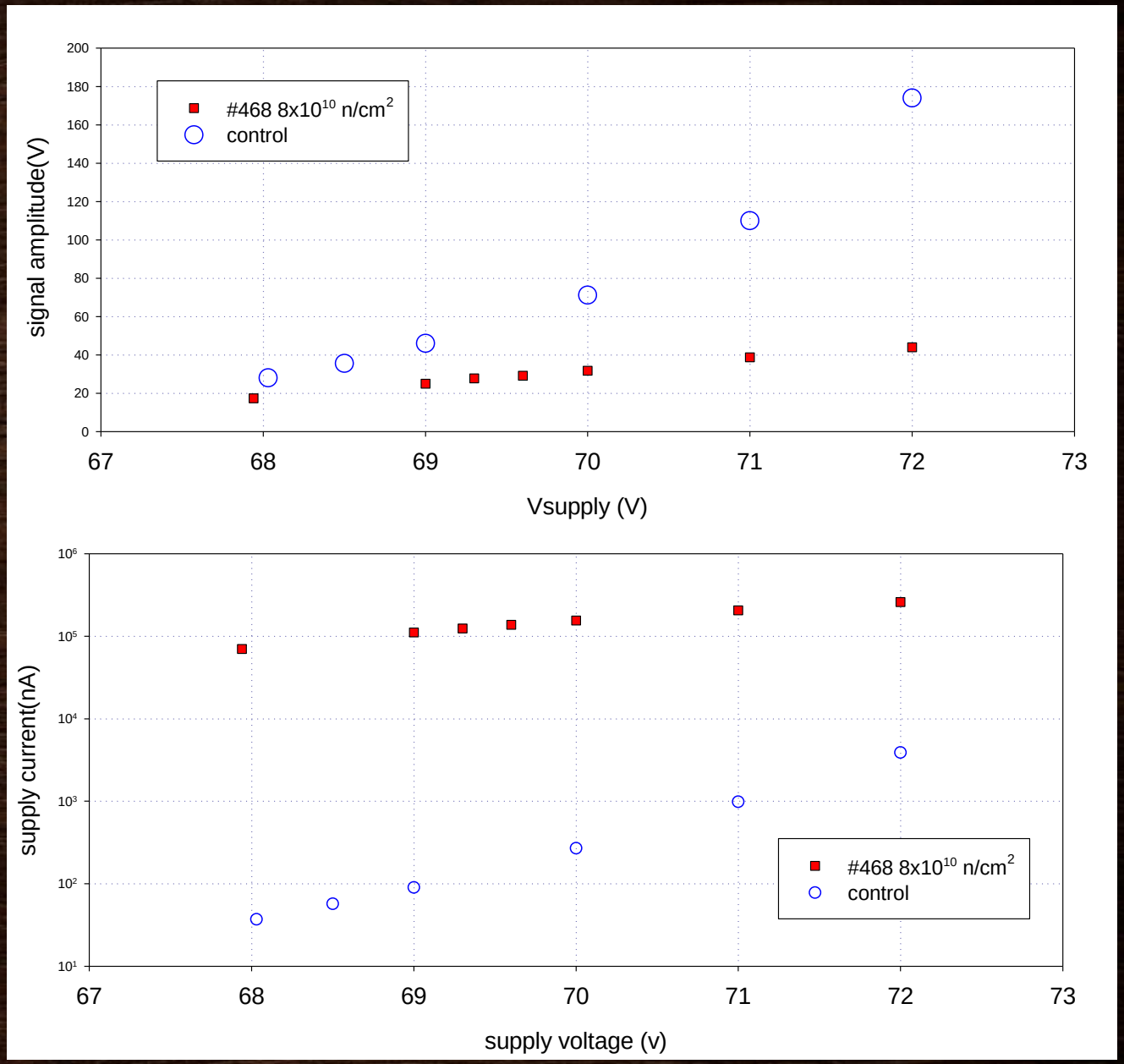
LED - pulsed sipm

observable effects of radiation exposure:

- signal amplitude decreases
- supply current increase



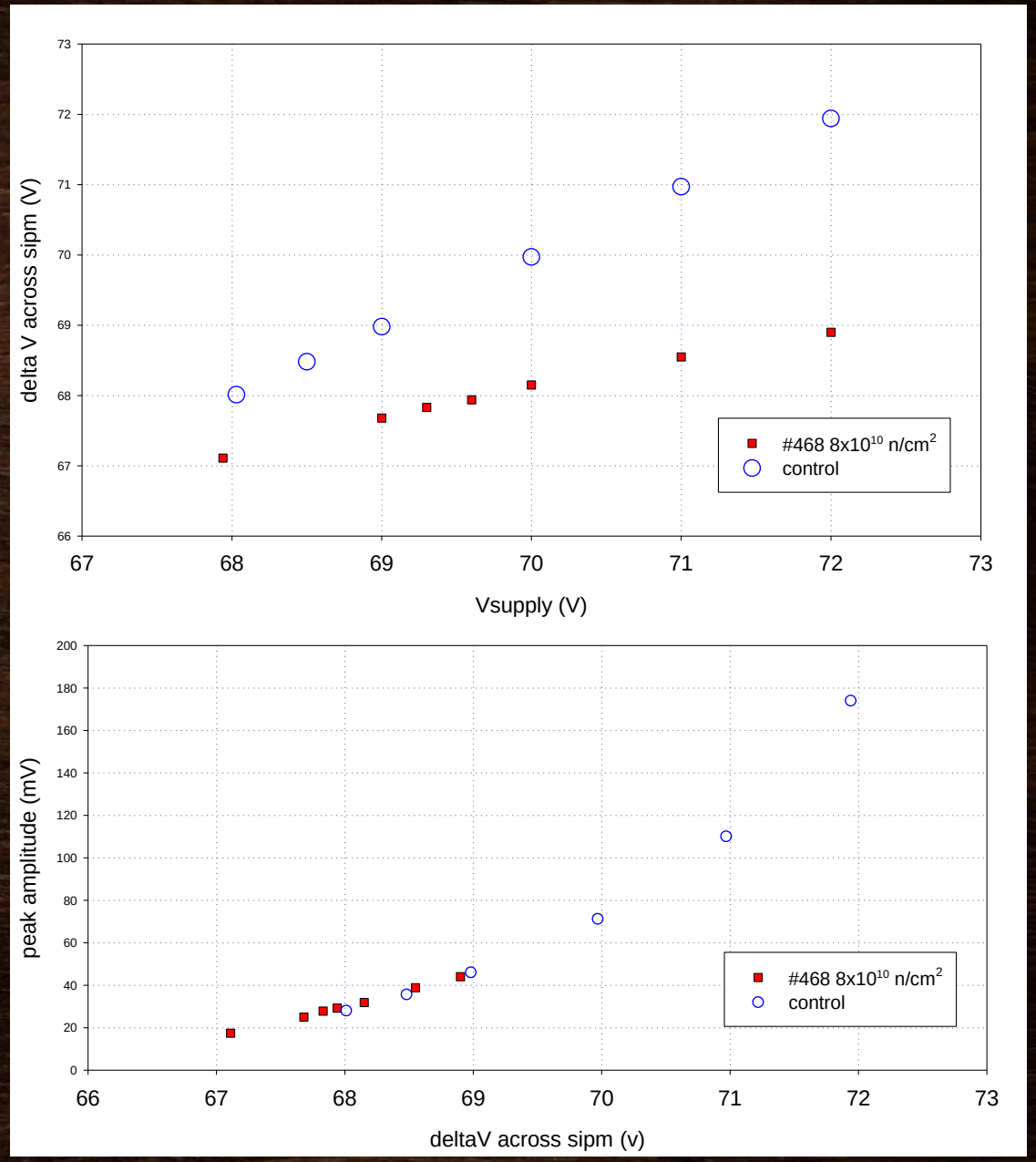
Sipm/Preamp output pulse



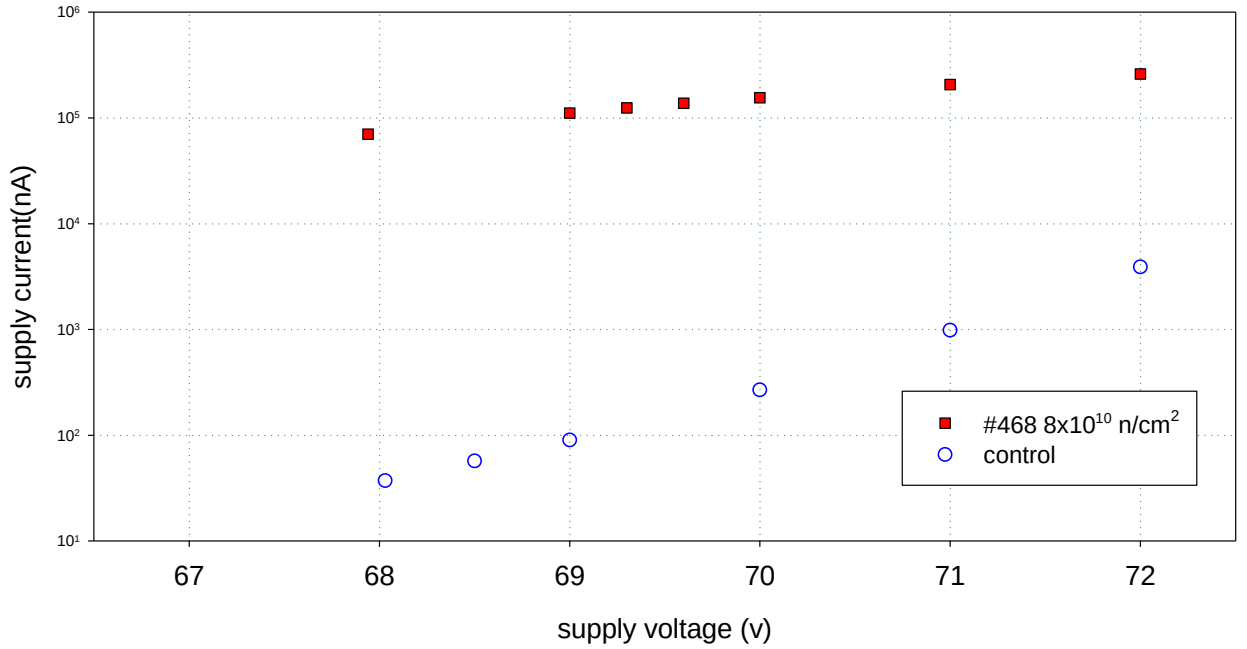
- In the undamaged (control) sipm, deltaV across the sipm ~ V_{supply}
- In the damaged device, deltaV < V_{supply}

- After irradiation, we observe a decrease in signal amplitude at constant supply voltage.
- Radiation Damage causes an increase in the sipm dark current. The increase in dark current results in greater voltage drop across resistive elements in the circuit, which causes a drop in the voltage across the sipm thereby reducing the sipm gain.

- If we maintain the actual delta V across the sipm and plot peak amplitude vs delta V, there is little if any change in the signal amplitude before and after irradiation to $8x10^{10}$ n/cm^2.

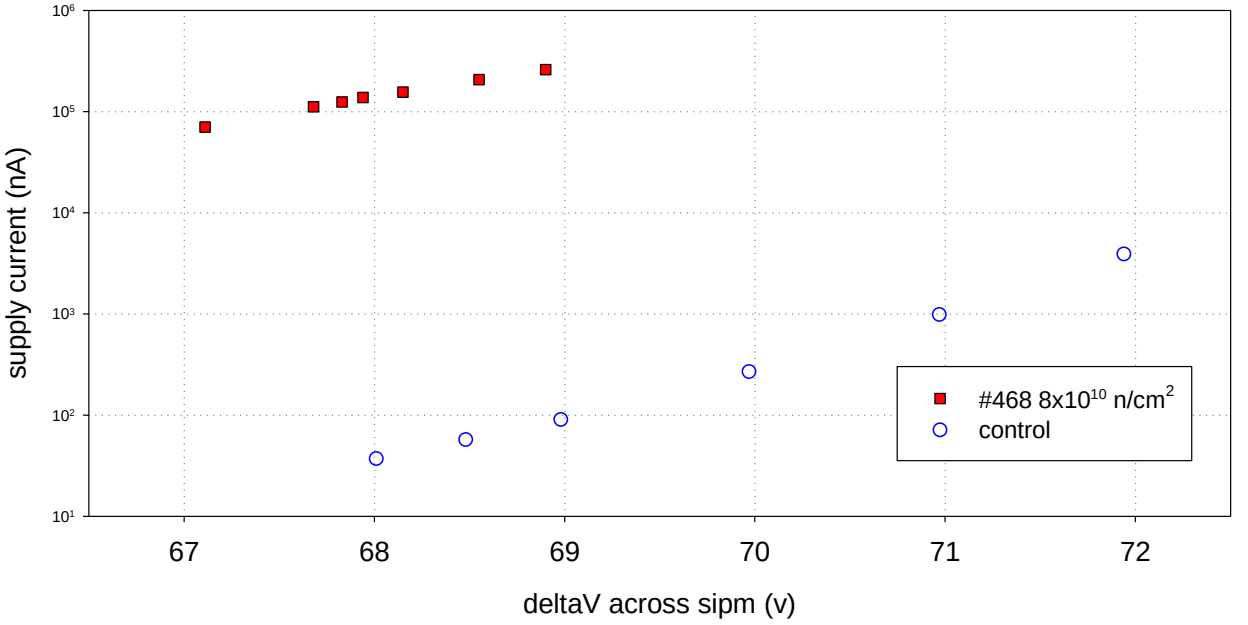


Change in sipm dark current after irradiation.



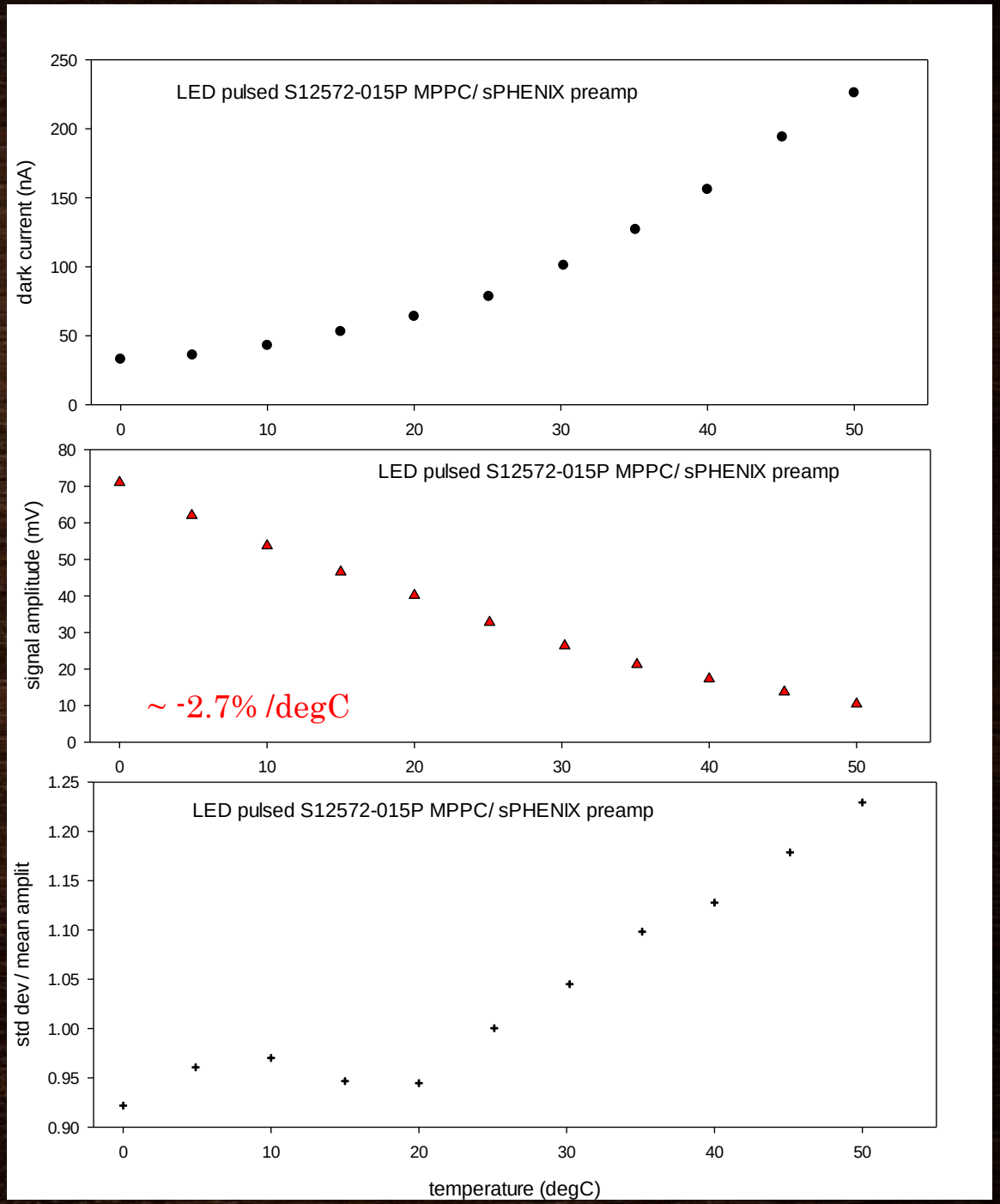
Change in current after correction for voltage drop.

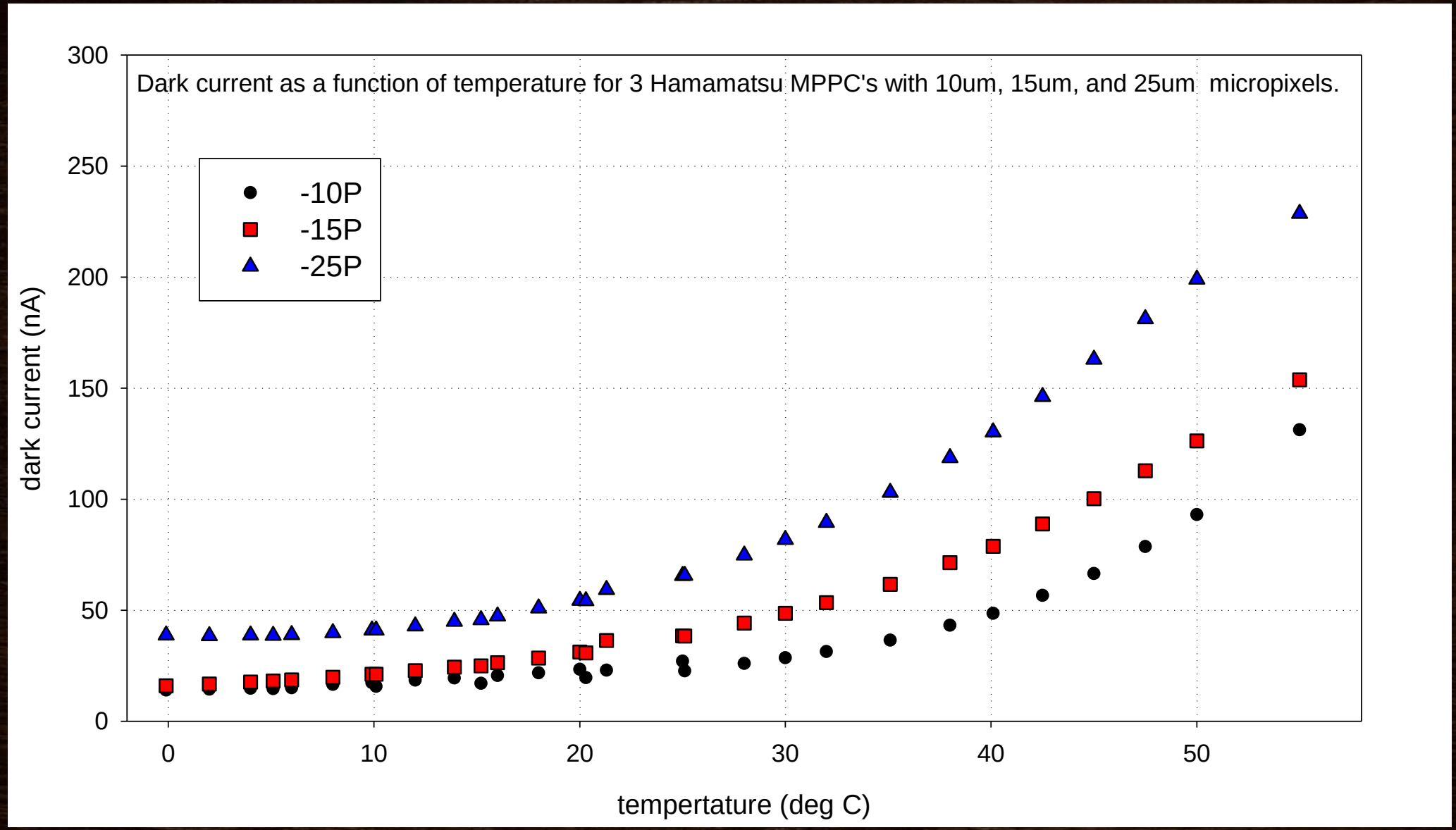
Increasing V_{supply} to keep the delta V across the sipm (and the gain) constant, results in an additional increase in the sipm circuit current.



EFFECT OF TEMPERATURE ON COMBINED MPPC+PREAMP

- S12572-015P MPPC / sPhenix preamp
  - pulsed LED
  - MPPC and Preamp inside temperature controlled cell
  - dark current increases with temperature
  - signal amplitude (gain) decreases with temperature
  - noise increases with temperature





Sipm dark current vs temp. (no preamp)